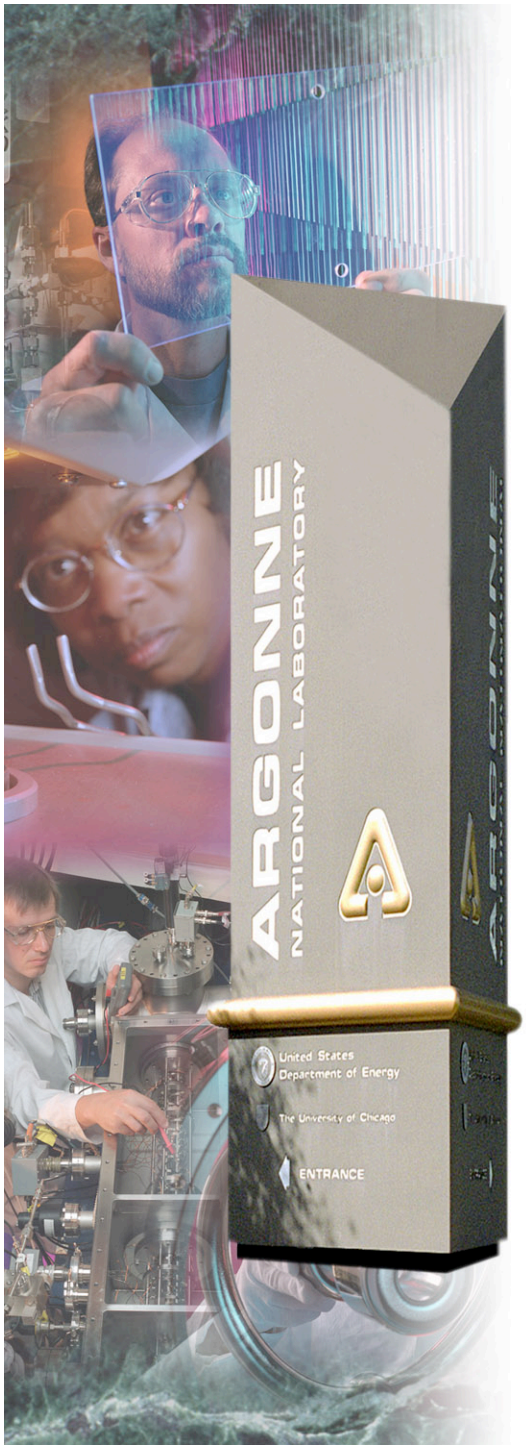


Science Highlights from Beamline 4-ID-C

John W. Freeland

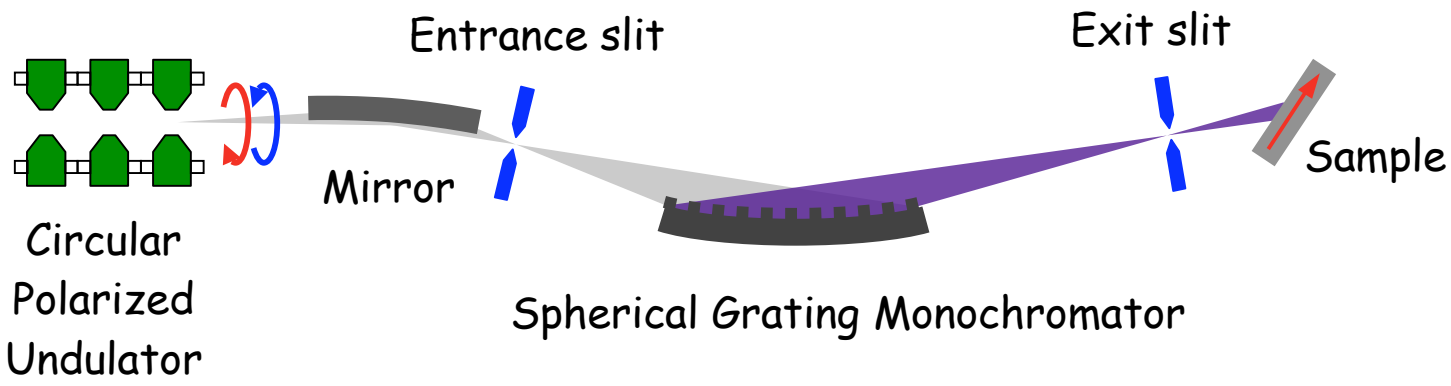
Advanced Photon Source
Argonne National Laboratory

Office of Science
U.S. Department of Energy

A U.S. Department of Energy
Office of Science Laboratory
Operated by The University of Chicago

APS Beamline 4-ID-C

Provides linear and circular polarization in 500-3000 eV range



Element specific electronic and magnetic properties

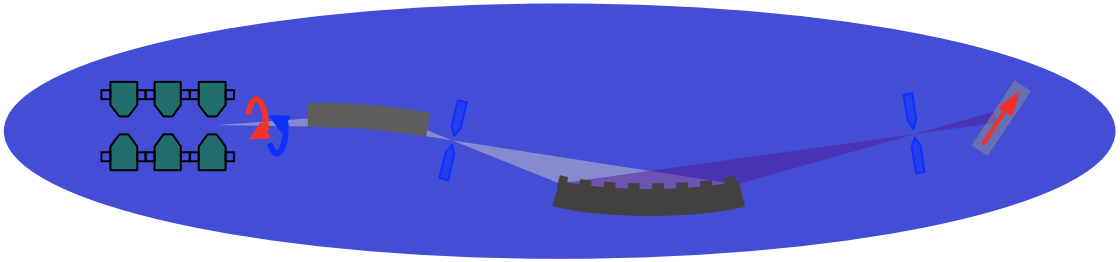
- X-ray magnetic circular dichroism (XMCD)
- X-ray magnetic linear dichroism (XMLD)
- X-ray resonant magnetic scattering (XRMS)

Ongoing 4-ID-C Programs

High Magnetic Fields (7T)

Time Resolved XMCD & PEEM

X-ray Resonant Magnetic Scattering



Staff: J.W. Freeland, D.J. Keavney, and R.A. Rosenberg

Postdocs: J. Han

Student: J. Kavich

Outside Users

X-ray Emission Spectroscopy

T.Calcott & D. Ederer

Spin-Resolved Photoemission

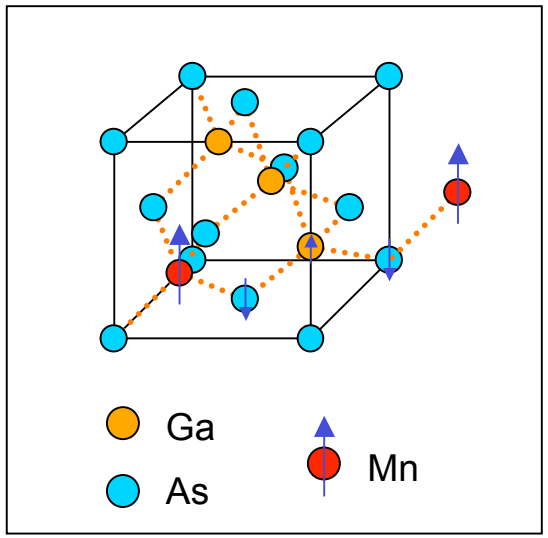
D. Waddill & J. Tobin

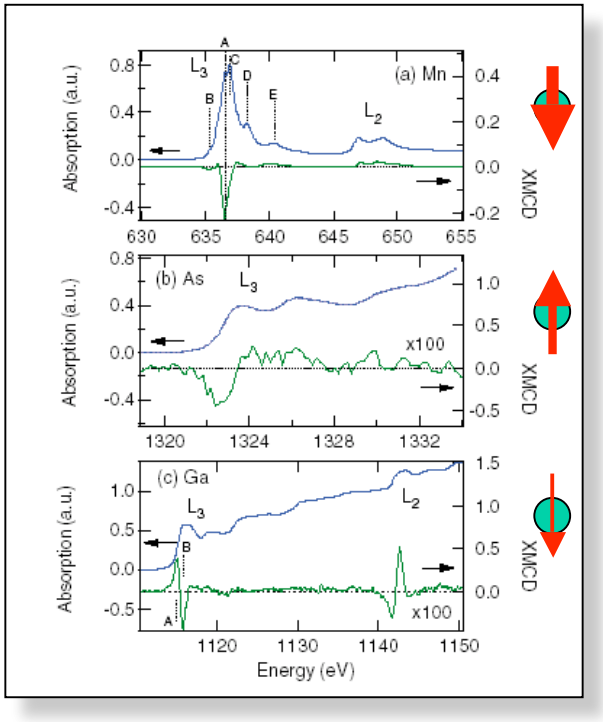
Ferromagnetic Semiconductors

Combining semiconducting gap with spin polarized carriers

Doping semiconductors with magnetic ions

$Ga_{1-x}Mn_xAs$ T_c ~ 110-150 K for x=4.9%





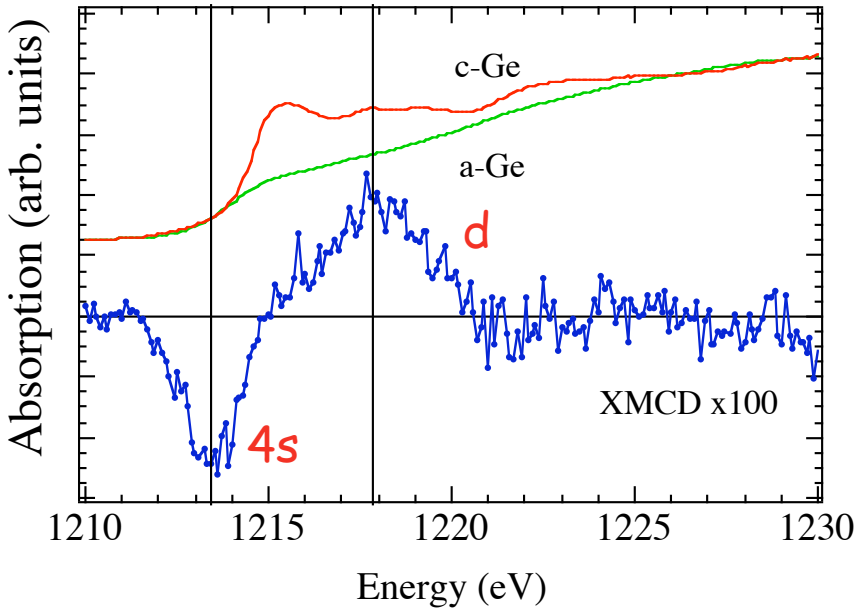
Spin configuration consistent with carrier-mediated predictions!

D. Keavney (APS), J. Shi (Utah), D. Awschalom (UCSB) et al. Phys. Rev. Lett. **91**, 187203 (2003).

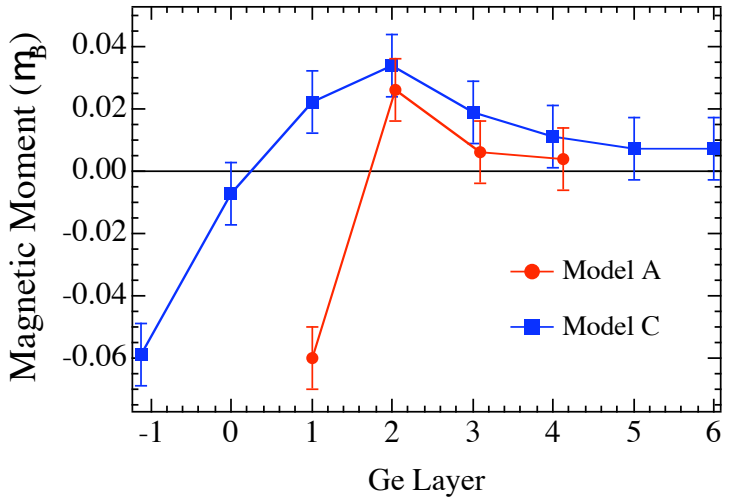
Induced Ge Moments at the Fe/Ge Interface

Probe induced magnetism on Ge at the Fe/Ge interface

Ge magnetism



LSDA Calculations



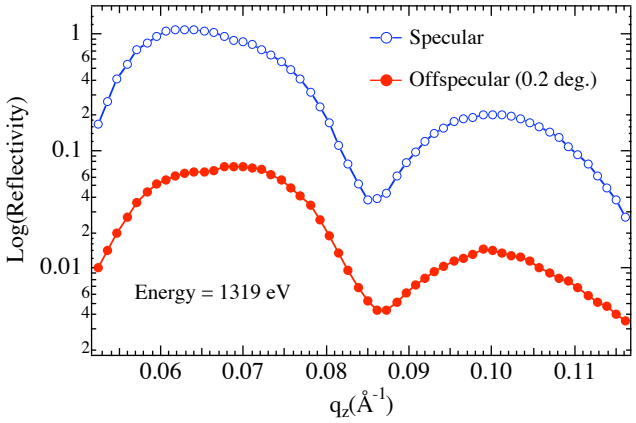
Small s and d moments (~0.01 m_B) antiparallel to Fe 3d moment

J.W. Freeland (APS) et al. Phys. Rev. B **70**, 33201 (2004).

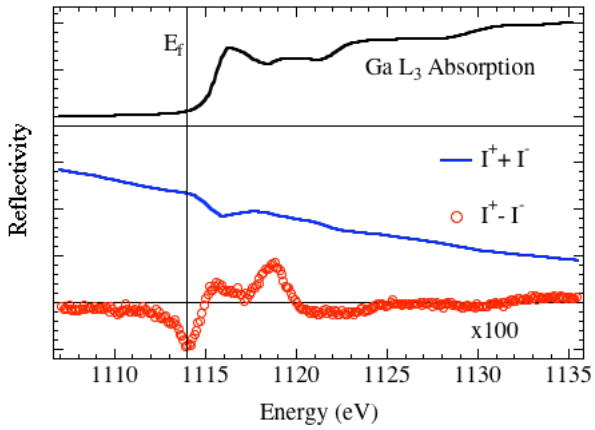
Influence of Interface Structure on Spin Injection

Role of interface morphology and magnetism on spin injection

Interface structure



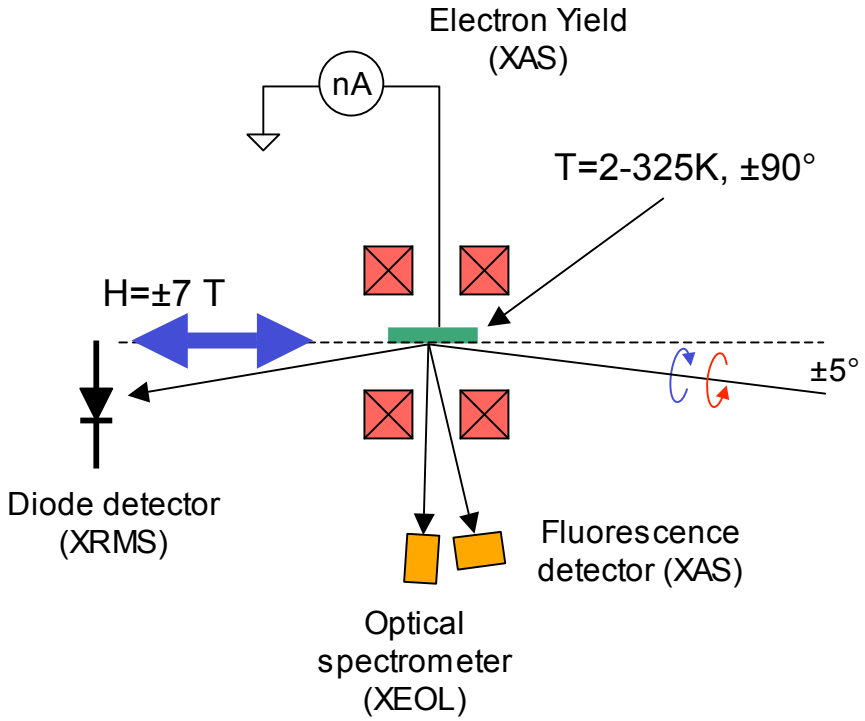
Interface magnetism

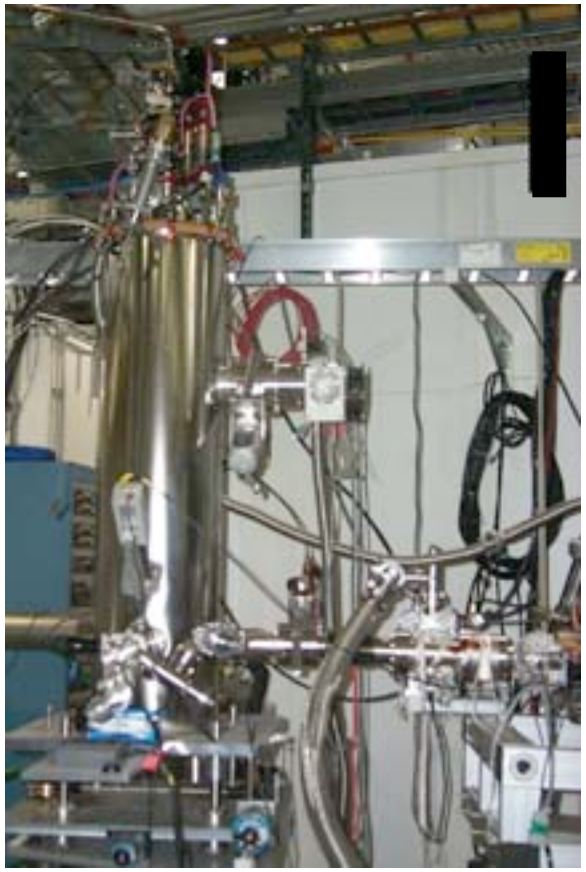


High quality surfaces key to tunneling spins into semiconductor

J.W. Freeland (APS) and A. T. Hanbicki, B. T. Jonker (Naval research Laboratory)

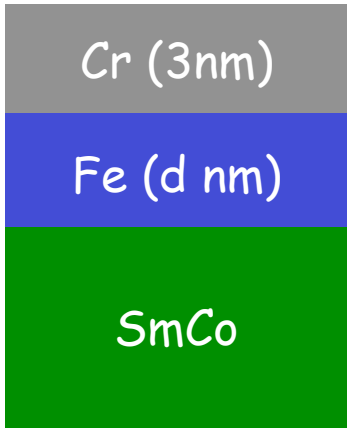
High Magnetic Fields

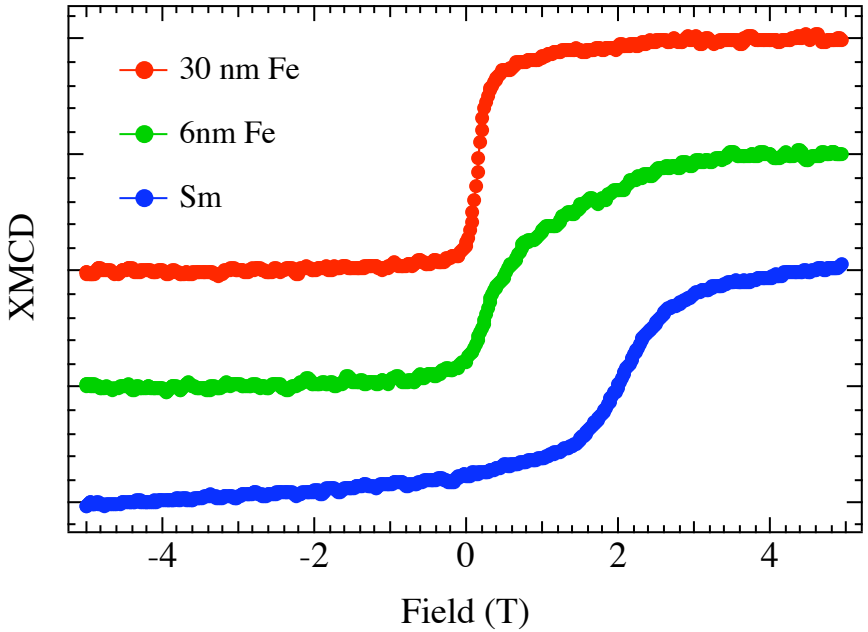




XMCD of Spring Magnets

Track exchange coupling in hard/soft phase nanocomposite magnets



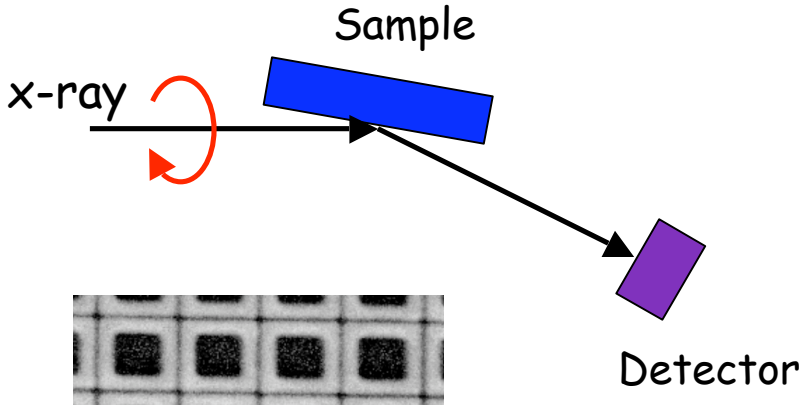


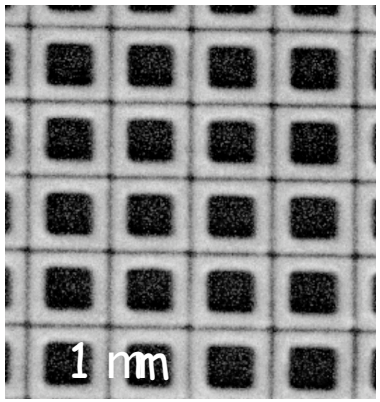
Minghui Yu and Ichiro Takeuchi, Univ. of Maryland, College Park

Submitted to App. Phys. Lett.

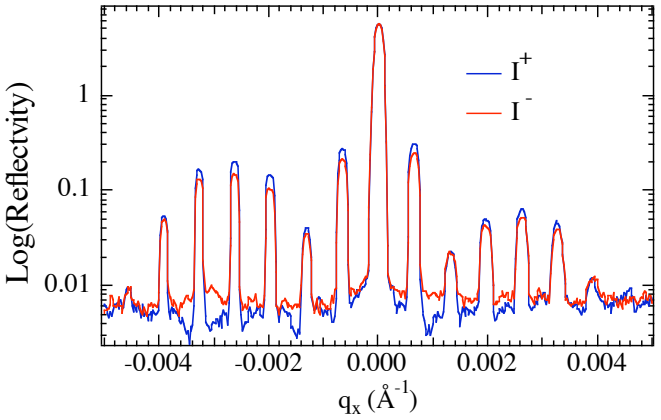
Domain Specific Magnetization of Nanostructures

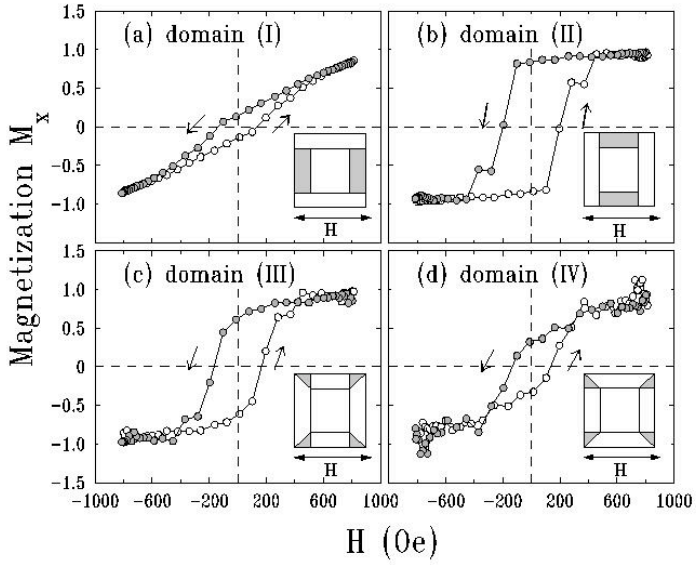
Scattering from magnetic nanostructures to study complex magnetic domains





Array of NiFe picture frames



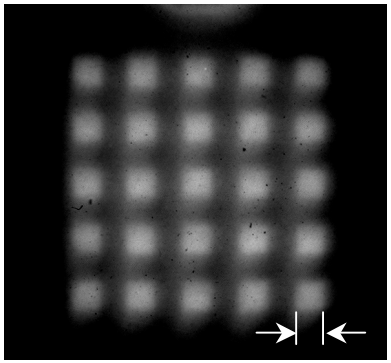


Extract domain dependent hysteresis!

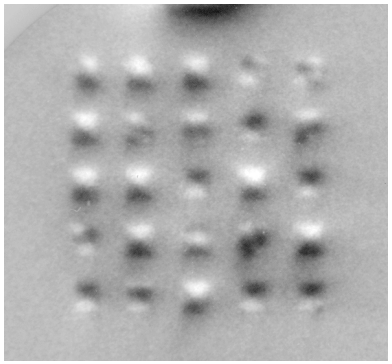
D.R. Lee (APS), V. Metlushko (UIC) et al. J. Appl Phys. **95**, 7016 (2004); cond-mat/0309672.

X-ray Photoemission Electron Microscopy

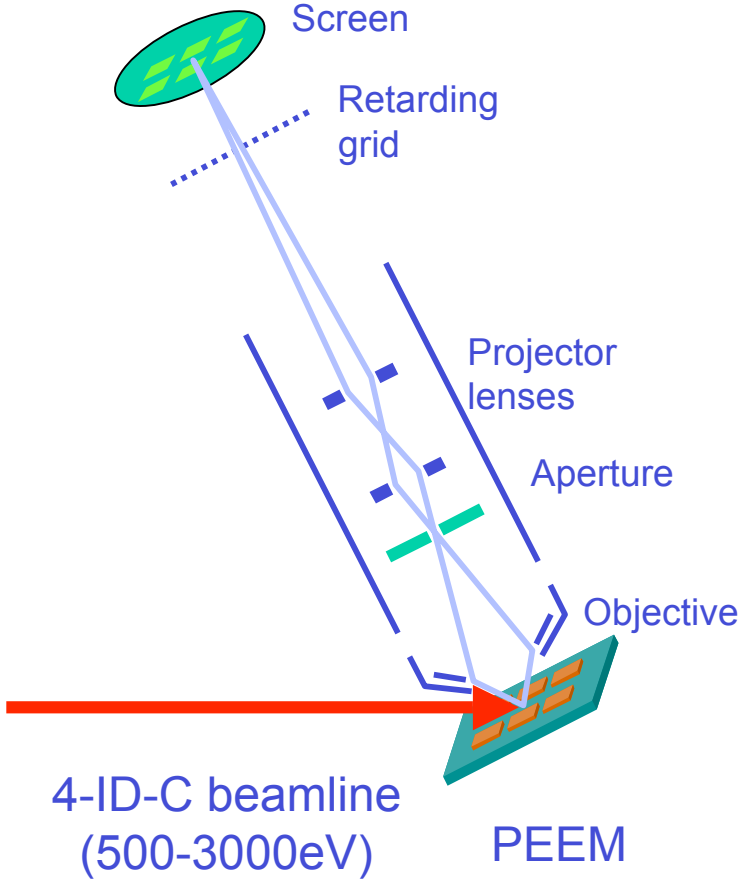
Chemical map (L+R)/2



Magnetic map (L-R)

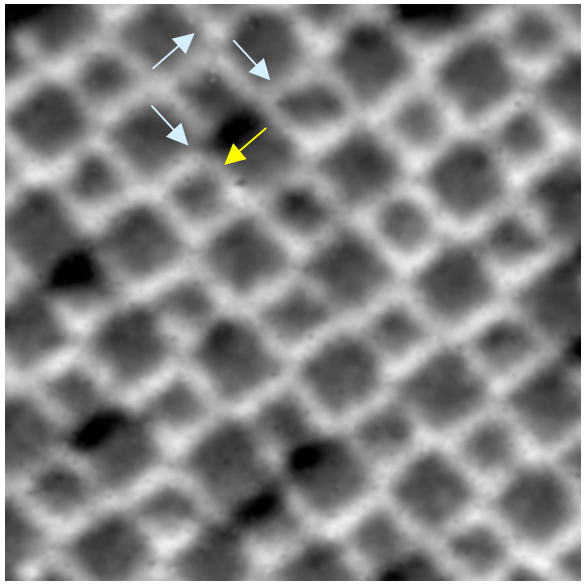


- Simultaneous direct chemical + magnetic contrast
- Full field
- No interaction with sample
- 100-120 nm resolution
  (20-40 nm target with K-B mirrors)

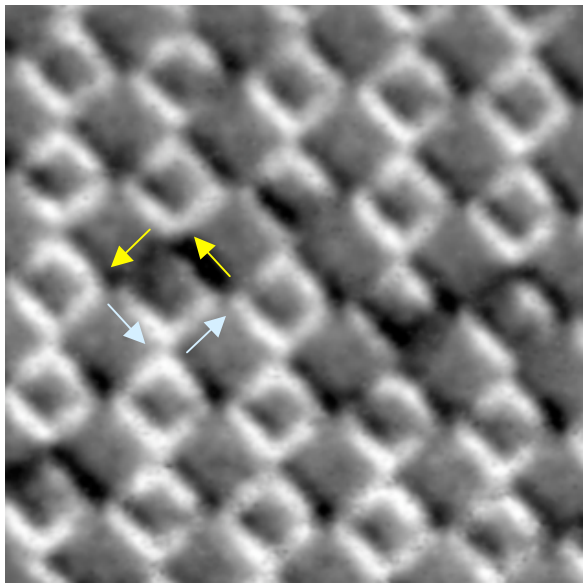


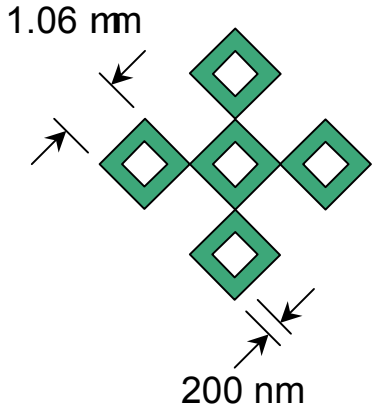
Coupling in NiFe rings

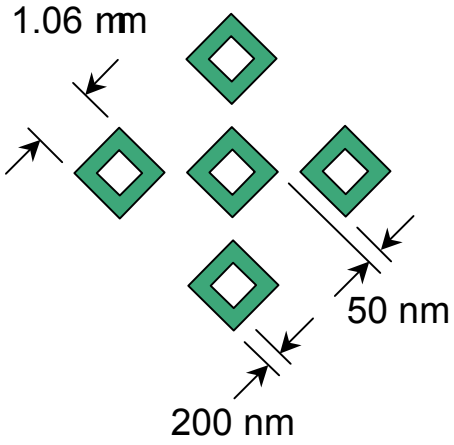
Touching



Non-touching

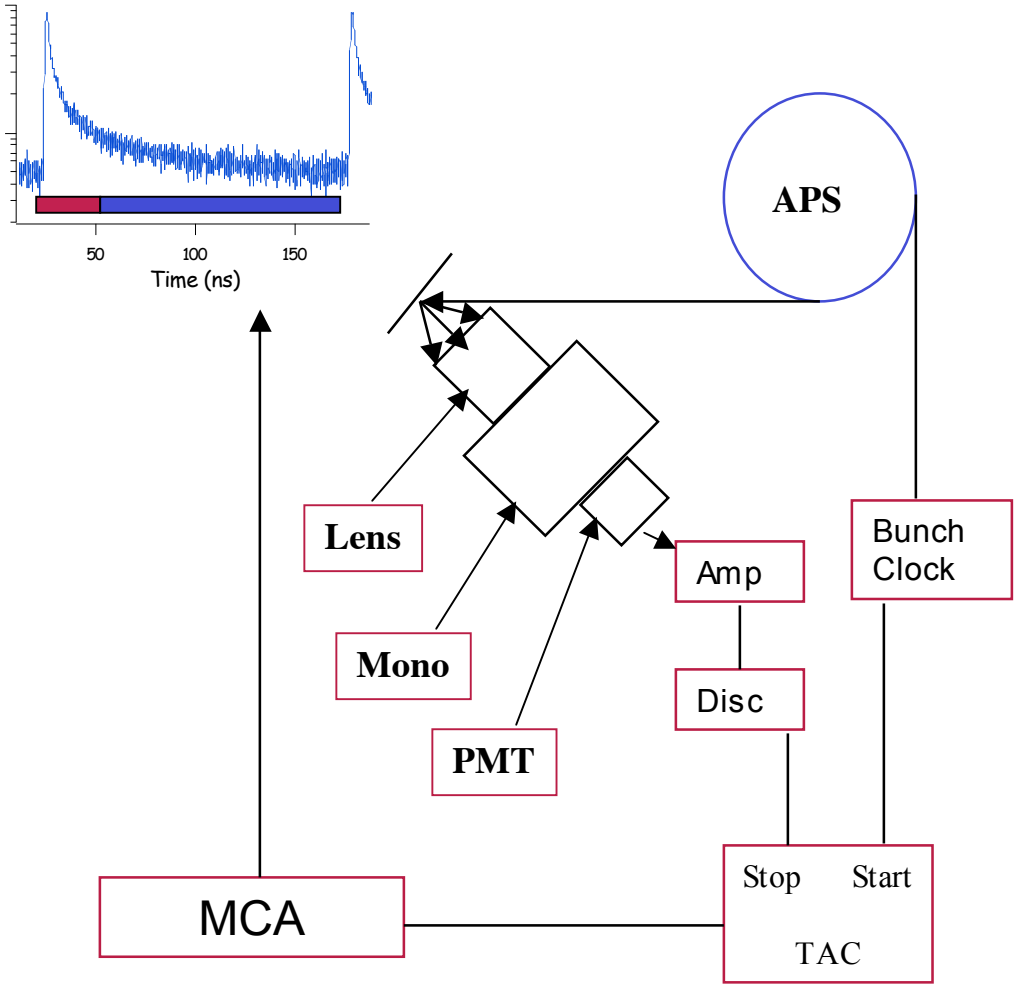


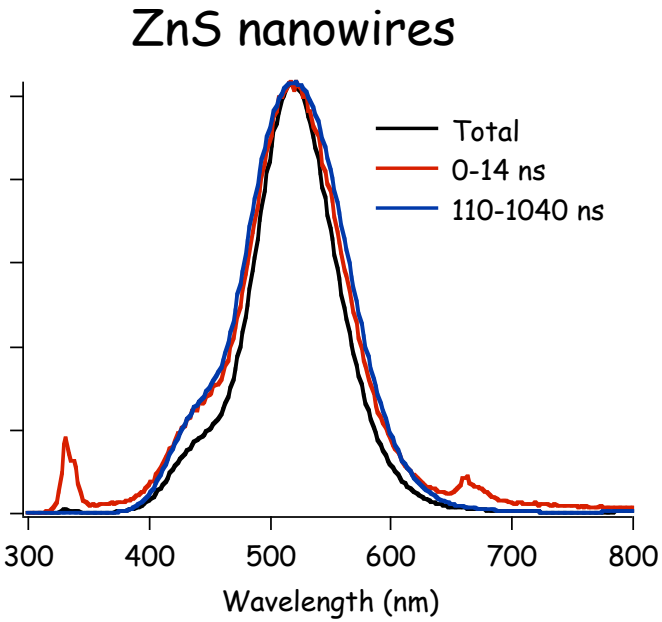




D. Keavney, D.R. Lee (APS), V. Metlushko, UIC

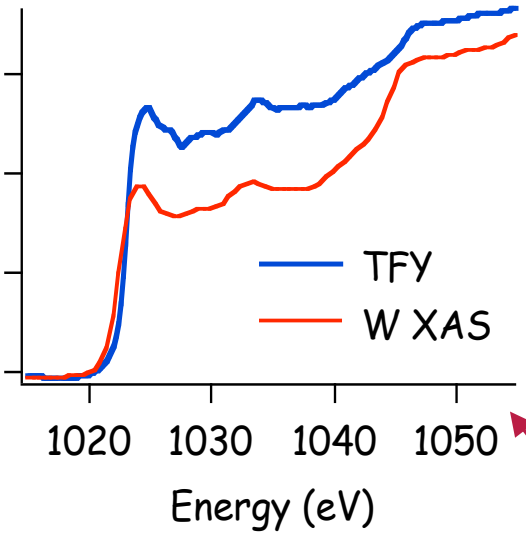
Time Resolved Optical Luminescence

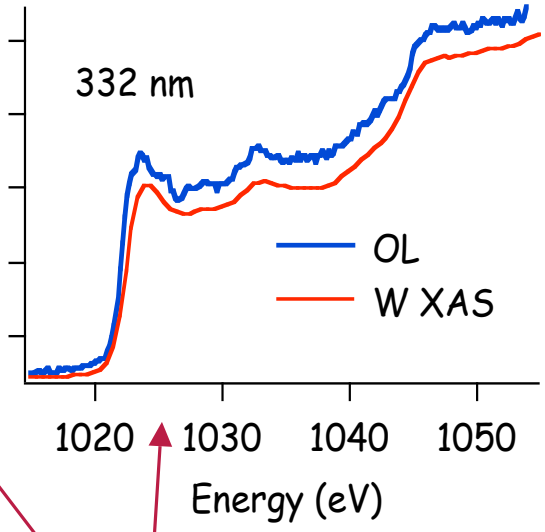


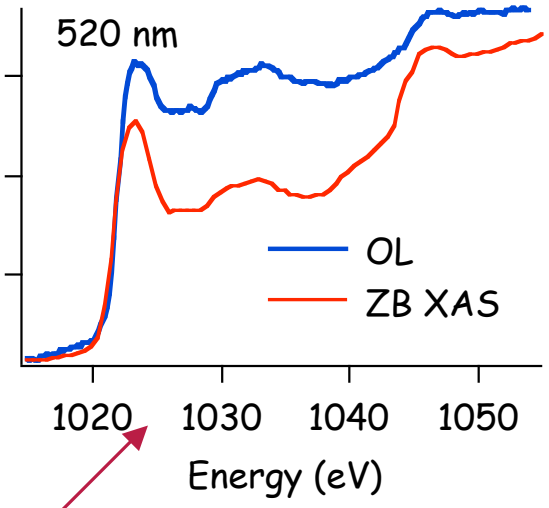


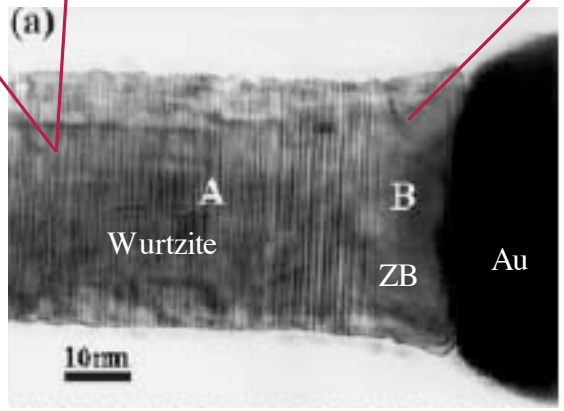
R.A. Rosenberg (APS)

ZnS Nanowire Luminescence









XAS Data: B. Gilbert et al, Phys. Rev. B 66, 245205 (2002).

Resonant Inelastic X-ray Scattering (RIXS)

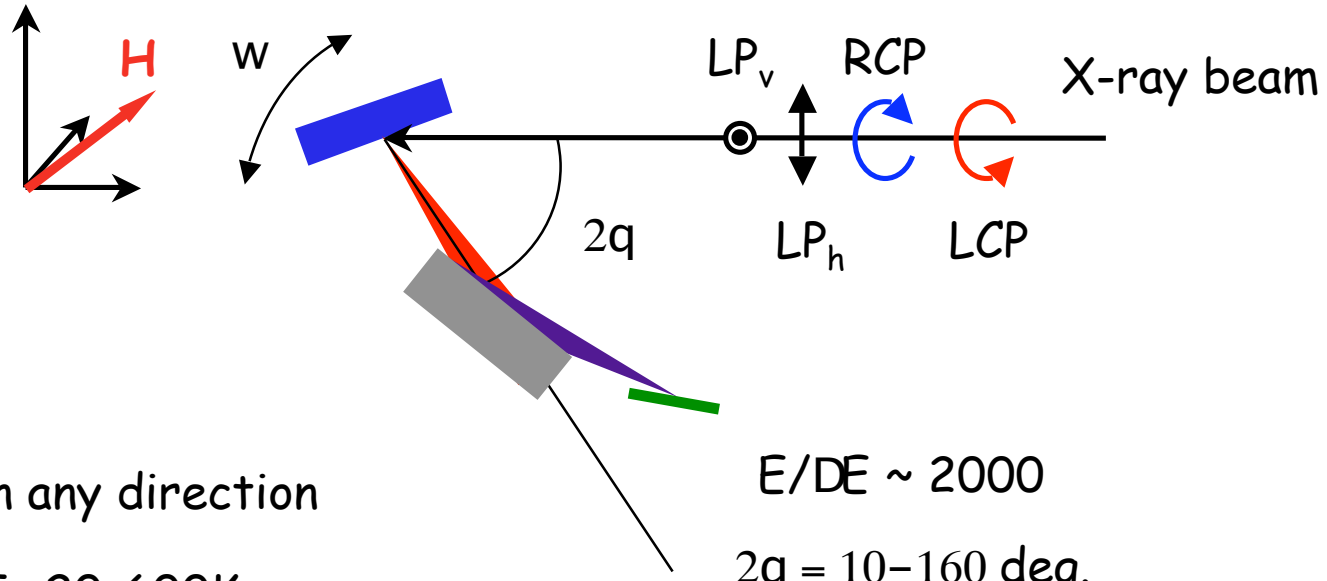
- BULK probe of occupied states
- Not influenced by applied magnetic fields
- Not influenced by charging … Insulators

Why Soft X-rays?

- Information about d electrons (**L** edges of Mn, Fe, Co , Ni, Cu)
  - ✓ Resonantly enhanced features
  - ✓ Large magnetic cross-sections at L edges
- Access to oxygen electronic/magnetic structure
- Information about Rare earth 4f electrons (M edges)

RIXS Endstation

Built at UT Knoxsville with DOE funding



- H 0-3T in any direction
- Sample T =20-600K

E/DE ~ 2000

$2q = 10-160$ deg.

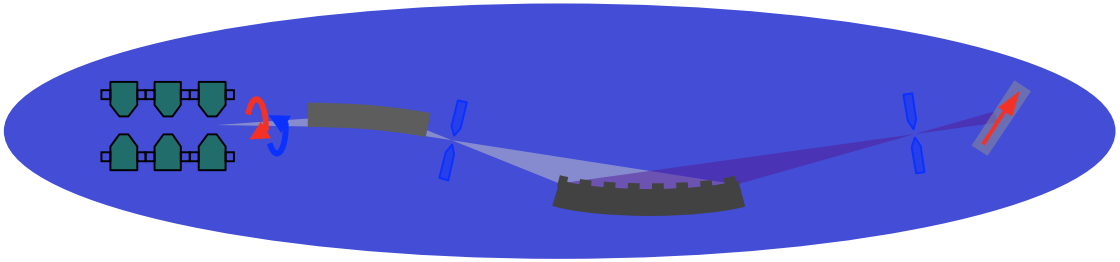
Begin commissioning in FY05

Ongoing 4-ID-C Programs

High Magnetic Fields (7T)

Time Resolved XMCD & PEEM

X-ray Resonant Magnetic Scattering



Staff: J.W. Freeland, D.J. Keavney, and R.A. Rosenberg

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Spin-Resolved Photoemission

D. Waddill & J. Tobin